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Original Research

Biochemical effects of exposure to electromagnetic field in mice

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ABSTRACT:

The present study evaluated the effects of electromagnetic field radiated from cell phones with frequency between 500 to 900 MHz on total protein, albumin, Blood Urea Nitrogen (BUN), creatinine, cholesterol, glucose, Alanine Amino Transferase (ALT), Aspartate Amino Transferase (AST) and Thyroid Stimulating Hormone (TSH) of Swiss albino mice. In this study, sixty adult Swiss albino mice were divided in three groups, each consisting of twenty animals. Test groups were exposed to electromagnetic wave twice a day for 21 days. Blood samples were prepared from heart and some biochemical factors were measured and statistical analysis was also performed using SPSS. According to the results BUN, ALT and AST were increased and the average amount of body weight, creatinine, fasting blood sugar, protein, albumin, cholesterol and TSH were decreased in the test group. Electromagnetic wave has influence on the biochemical parameters in mice.

Keywords:
Biochemical effect, Electromagnetic waves, Mice

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INTRODUCTION

Electromagnetic (EM) radiation is a form of energy propagated through free space and has different types, such as Sunlight, visible light, infrared and ultraviolet radiations, radio waves, microwaves and X-rays. Electromagnetic radiation is numerously use in industry, military and medicine. The Radio Frequency (RF) portion is any of the electromagnetic wave (spectrum between 0.5 MHz–100 GHz) and seems to affect some of organs and systems. The emphasis of telecommunication services using electromagnetic frequency greatly enhance the ability of human to communicate with each other. Today, smart cell phones are not only used for making voice calls but also for many other applications, such as electronic banking and web browsing. The increased usage and growing popularity of wireless technologies in RF and EMF range represents one of the fast growing environmental influences. This usage is not without a lot of controversy and public concern on the possible adverse health effect associated with the energies emitted by these technologies (Repacholi, 1999 ; Schwan and Foster, 1980).

In recent years, some studies evaluate the probable bio-effects of electromagnetic waves on human health (Jolanta *et al.,* 2001). Some investigations show that microwave exposure may affect the hematological and biochemical parameters of exposed animals (Bonhomme-Faivre *et al.,* 2003). Little is known about health hazards from exposure to different sources of non-ionizing radiation. High exposure to non-ionizing radiation acutely affects sensitive organs, which mostly depends on radiations intensity, frequency, and exposure duration (Goldini, 1994). Epidemiological researches cannot find a correlation between the effects of different intensities of electromagnetic radiation and the appearance of any particular health hazard (Reipert *et al.,* 1997; Hatch *et al.,* 1998; Lacy-Hulbert *et al.,* 1998; Day, 1999). In contrast, some studies have demonstrated an increase in childhood leukemia in children from populations exposed to electromagnetic fields (Thomson *et al.,* 1988). Additionally, the result of some researches indicate that magnetic radiation is effective in cancer induction as co-carcinogenic factors and intensify the effects of other mutagenic factors (Baum *et al.,* 1995; Mevissen *et al.,* l995). The aim of this study was to evaluate some hematological and biochemical parameters effects of long term radiofrequency Swiss albino mice as surrogate.

MATERALS AND METHODS

Sixty adult Swiss albino mice (30 male and 30 female), 4 weeks old and weighing 30±3 g were used in this study. The mice were purchased from Research Center and Experimental Animal House of Ahwaz Jundishapour University of Medical Sciences, Ahwaz, Iran and kept for two weeks prior to study. The animals were housed in clean polypropylene cages and maintained under laboratory standard controlled conditions of temperature (22 ±1ºC), light (12h/12h light/ dark cycle) and humidity (50±5%). They were fed by commercial balanced pellets and water was supplied continuously. The Animal Ethics Committee of Ahwaz Jundishapour University of Medical Sciences has approved the experimental protocol.

At the beginning, blood samples were collected from heart under light with ether anesthesia from 20 mice (10 male and 10 female) (Dorostghoal *et al.,* 2013). For biochemical analysis, blood sample was collected into sample tube without anticoagulant and centrifuged at 3500 rpm for 5 minutes. Serum samples were separated in micro tubes and subjected to different biochemical assays. Forty mice were divided into two groups (control and test). Test group (n=20) were exposed by cell phone electromagnetic waves with constant frequency in the range of 500 to 900 MHz. Radiation took place once in the morning from 09:00 to 11:00 hours and once in the afternoon from 14:00 to 16:00 hours for 20 days. After enough radiation exposure, the animals were returned to

Table 1. Mean values (Mean±SD) of Body weight, BUN, Creatinine, ALT and AST in the test groups

	Body weight (g)	BUN (mg/dl)	Creatinine (mg/dl)	ALT (Unit/ml)	AST (Unit/ml)
Control	79.40±8.16	18.8±1.09	0.62±0.05	92.80±13.25	187.5±59.49
Test	64.28±9.26	27.00±0.83	0.600±0.08	101.66±55.94	249.33±153.00

animal room. Environmental conditions of the experiment room resembled those of the animal room. By the end of irradiation, all mice were anesthetized with ether and the required blood for hematology was prepared by taking blood directly from the heart.

Blood samples were prepared from 10 mice of test group (5 male and 5 female). The last 10 mice in test group were exposed by electromagnetic radiation for 20days longer. At the end of examination, all remaining mice (10 mice of test and 20 mice of control group) were anesthetized with ether and blood samples were prepared by taking from the heart. Serum samples were separated from blood samples as explained above. Total protein, albumin, Blood Urea Nitrogen (BUN), creatinine, cholesterol, glucose, Alanine Amino Transferase (ALT), Aspartate Amino Transferase (AST) and Thyroid Stimulating Hormone (TSH) were measured in serum samples by biochemistry Autoanalyzer Global 240, BPC Italy, (End Point method), Elisys UNO Germany. Statistical Analysis of differences between exposed animals and controls were done by SPSS program (statistical package for social sciences Inc. Chicago, Illinois). Statistical analysis was done using analysis of variance (ANOVA) followed by Tukey's test. All data are presented as mean ± Standard Deviation (SD). $P<0.05$ denoted a significant difference.

RESULTS

Table 1 demonstrates mean values of Body weight, BUN, Creatinine, ALT and AST in the control and test groups. Electromagnetic field radiation caused decrease in body weight with a value of 64.28±9.26 g and creatinine with a value of 0.600±0.08 mg/dl and increase in average amount of BUN with a value of 27.00±0.83 mg/dl, ALT with a value of 101.66±55.94 unit/ml and AST with a value of 249.33±153.00 unit/ml compared to the control group. Table 2 demonstrates mean values of FBS, TSH, protein, albumin and cholesterol in the control and test groups, under the influence of electromagnetic waves in the test group average amount of FBS with a value of 7.36±0.002 mg/dl, TSH with a value of 0.48±0.25 µIU/ml, protein with a value of 5.26±0.25 mg/dl, albumin with a value of 3.06±0.08 mg/dl, cholesterol with a value of 65.50±5.19 mg/dl increased in comparison with control group.

DISCUSSION

Measurements of blood hematological and biochemical parameters are the most important factors to evaluate the health status of human and animals. The present study aimed to investigate the effects of cell phone waves on different blood factors. Some studies have also investigated the effect of electromagnetic wave exposure on blood parameters. In this regard, Abdel-Aziz (2010) investigated the use of vitamin C and E for reducing the potential effect of a 900MHz electromagnetic wave (for 8 h over two weeks) on hematological parameters in rats. Some studies reveal that cell phone electromagnetic waves can produce different biological effects. Occurrence of biological reactions following RF irradiation could indicate that these waves might be harmful. In this regard, similar to

Table 2. Mean values (Mean±SD) of FBS, TSH, protein, albumin, cholesterol in the test groups

	FBS (mg/dl)	TSH (µIU/ml)	Protein (mg/dl)	Albumin (mg/dl)	Cholesterol (mg/dl)
Control	23.37±0.003	0.70±0.30	5.68±0.25	3.24±0.05	75.20±7.22
Test	7.36±0.002	0.48±0.25	5.26±0.25	3.06±0.08	65.50±5.19

the current study. In one study was investigated the use of vitamin C and E for reducing the potential effect of a 900 MHz electromagnetic wave on hematologic parameters in Rats. In another study the effect of mobile phone waves on the hematopoietic system. The results showed that mobile phone electromagnetic exposure to the hematopoietic system had no effects on blood factors. However, histopathological studies of the liver, spleen, and bone marrow showed a significant impact, which was in simillar with the results of the presents study in terms of most blood factors (Baharara, *et al.,* 2009). The change in biochemical factors in radiated mice showed probably hepatic damage. The results showed that sub-acute exposure to electromagnetic waves increased significantly plasmatic ALT and AST. Decrease in body weight in test group could not be related to dehydration but probably to the hypoxia status known to alter the body weight. It seems that, free radicals and oxidative stress are the major cause of hematological damage.

CONCLUSION

This study was conducted to evaluate the effect of electromagnetic radiation on some hematological and biochemical parameters effects of long term radiofrequency of Swiss Albino mice. In conclusion, this study provided evidence that electromagnetic waves have significant effects on the blood of mice.

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